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ENVIRONMENTAL STABILITY TESTING OF A COATED, ELASTOMERIC DENTAL--ETC(U)
SEP 79 G J SHEMAKA, W W TENERO DAMD17-78-C-8084

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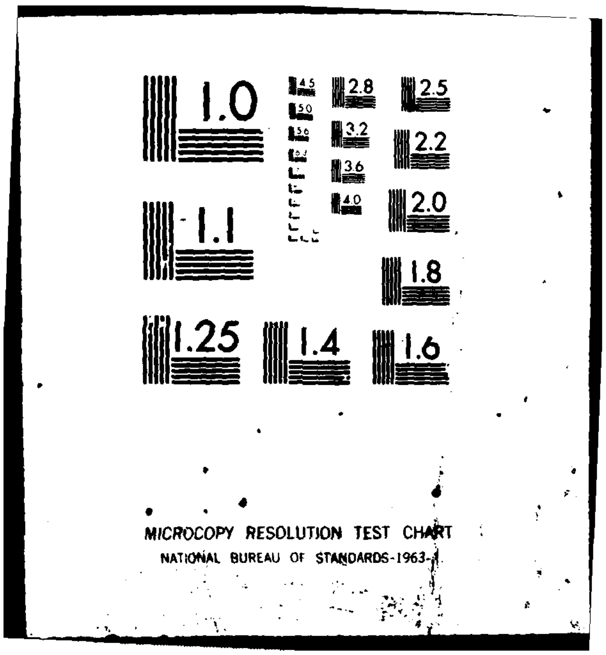
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REPORT #2

Environmental Stability Testing of a Coated, Elastomeric Dental Ribbon

Final Report

Gary J. Shemaka
*William W. Tenero

Cooper Dental Products, Portland, Oregon
*Spring borne Industries, Enfield, Connecticut

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September, 1979

Supported by

U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21701

Contract No. DAMD 17-78-C-8084

Cooper Laboratories
110 E. Hanover Avenue
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A coated, elastomeric dental ribbon developed by Dr. Paul Jaffe with Cooper Laboratories was taken through a series of physical tests at various environmental conditions to determine its suitability for military application. Tensile properties and Tensile Impact Strengths were determined at -40, 0, 73 and 120° Fahrenheit. Yield Strengths were 3730, 2170, 1130 and 1100 (p.s.i.) respectively. Break Strengths were 4150, 5030, 5260 and > 4500 (p.s.i.) respectively. Percent Elongations at breakage were 540, 640, 600 and > 700

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) (percent) respectively. Modulus were 5.0, 0.18, 0.14 and 0.08 (x10^5 p.s.i.) respectively. The Tensile Impact Strengths were 180, 520, 580 and 720 (ft. -lbs./in.^{2}) respectively.

The dental tape was placed in circulating air ovens at room temperature as a control, at 160°F with 90% relative humidity, at 194°F and 230°F for six and twelve weeks. After exposure, the specimens were removed and allowed to condition for a minimum of 40 hours at 73°F with 50% relative humidity. They were again tested for Tensile properties and Tensile Impact Strength. The Yield Strengths were 1130, 1630, 1830, 1380, 1390 and 2200 (p.s.i.) respectively. The Break Strengths were 5260, 4930, 3910, 2300, 1660 and 2700 (p.s.i.) respectively. The Percent Elongations at breakage were 600, 1060, 850, 790, 56 and 590 (percent) respectively. The Modulus were 0.14, 0.13, 0.14, 0.14, 0.13 and 0.71 (x10^5 p.s.i.) respectively. The Tensile Impact Strengths were 580, 331, 220, 500, 310 and 13 (ft. -lbs./in^2). Samples that were placed in the oven at 230°F for twelve weeks and samples at 266°F for 1, 3, 6 and 12 weeks were found too brittle to test.

No blocking was observed at -60, 73 and 160°F for a maximum of one month duration at 0.5 p.s.i. pressure. Little dimensional changes were noted at 160°F with 90% relative humidity, 194°F and 230°F, up to twelve weeks. Samples exposed at 266°F for six weeks were too brittle to be tested.

In conclusion, the coated elastomeric tape was found acceptable for use in a temperature range of 0 to 120°F. Due to high Modulus and low Tensile Impact Strength, the product will not function at -40°F. It was found suitable for storage at 194°F and 160°F with 90% relative humidity for twelve weeks. When stored at 230°F, the material proved too brittle for its intended use.

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REPORT #2

Environmental Stability Testing of a Coated, Elastomeric Dental Ribbon

Final Report

Gary J. Shemaka
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Summary:

A coated, elastomeric dental ribbon developed by Dr. Paul Jaffe with Cooper Laboratories was taken through a series of physical tests at various environmental conditions to determine its suitability for military application. Tensile properties and Tensile Impact Strengths were determined at -40, 0, 73 and 120°Fahrenheit. Yield Strengths were 3730, 2170, 1130 and 1100 (p.s.i.) respectively. Break Strengths were 4150, 5030, 5260 and >4500 (p.s.i.) respectively. Percent Elongations at breakage were 540, 640, 600 and > 700 (percent) respectively. Modulus were 5.0, 0.18, 0.14 and 0.08 (x 10 p.s.i.) respectively. The Tensile Impact Strengths were 180, 520, 580 and 720 (ft.-lbs./in.^{2}) respectively.

The dental tape was placed in circulating air ovens at room temperature as a control, at 160°F with 90% relative humidity, at 194°F and 230°F for six and twelve weeks. After exposure, the specimens were removed and allowed to condition for a minimum of 40 hours at 73°F with 50% relative humidity. They were again tested for Tensile properties and Tensile Impact Strength. The Yield Strengths were 1130, 1630, 1830, 1380, 1390 and 2200 (p.s.i.) respectively. The Break Strengths were 5260, 4930, 3910, 2300, 1660 and 2700 (p.s.i.) respectively. The Percent Elongations at breakage were 600, 1060, 850, 790, 560 and 590 (percent) respectively. The Modulus were 0.14, 0.13, 0.14, 0.14, 0.13 and 0.71 (x 10 p.s.i.) respectively. The Tensile Impact Strengths were 580, 331, 220, 500, 310 and 13 (ft.-lbs./in.^{2}). Samples that were placed in the oven at 230°F for twelve weeks and samples at 266°F for 1, 3, 6 and 12 weeks were found too brittle to test.

No blocking was observed at -60, 73 and 160°F for a maximum of one month duation at 0.5 p.s.i. pressure. Little dimensional changes were noted at 160°F with 90% relative humidity, 194°F and 230°F, up to twelve weeks. Samples exposed at 266°F for six weeks were too brittle to be tested.

In conclusion, the coated elastomeric tape was found acceptable for use in a temperature range of 0 to 120°F. Due to high Modulus and low Tensile Impact Strength, the product will not function at -40°F. It was found suitable for storage at 194°F and 160°F with 90% relative humidity for twelve weeks. When stored at 230°F, the material proved too brittle for its intended use.

Table of Contents

Body of the Report:

Title: Environmental Stability Testing of a Coated, Elastomeric Ribbon

Objective:

To define and monitor the rate of degradation of various physical properites of a coated, elastomeric dental ribbon under several thermal and humidifing conditions. The physical properties investigated were Yield Strength, Break Strength, Percent Elongation at Breakage, Modulus, Tensile Impact Strength, Blocking Characteristics and Dimensional Changes.

Methods and Materials:

Cooper Laboratories supplied 500 coated Hytrel strips measuring 4 x 3/16 inches. Springborne Industries supplied the necessary conditioning chambers and instron units to perform the following tests:

A. Tensile Properties at 120°F, 73°F, 0°F, and -40°F
A.S.T.M D882 and D759 Method A

Apparatus:	Instron Tensile Tester TM
Grip Separation:	1.0 in. Str., 2.0 in. Mod.
Gauge Length:	1.0 in. Str., 2.0 in. Mod.
Crosshead Speed:	20.0 in/min. Str., 2.0 in./min. Mod.
Chart Speed:	5.0 in./min. Str., 20 in./min. Mod.
Load Range:	0-10 lbs. Str., 0-1 lb. Mod.

B. Tensile Impact Strength at 120°F, 73°F, 0°F, and -40°F
A.S.T.M. D759 and D&R Spec

The strip specimens were tested for Tensile Impact Strength using a modified Baldwin Impact Tester. A specific fixture holds the specimen at 90° to the impact pendulum. A test gauge-length of 0.50 inches was used. The load capacity of the appartus is 2 ft. -lbs.

C. Degradation of Tensile Properties and Tensile Impact Strength when exposed at 194°F, 230°F, 266°F and 160°F at 90% Relative Humidity for six and twelve weeks.
A.S.T.M. D794 and E145

D. Blocking Characteristics at 160°F, 73°F and -60°F
FTMS 101B method 3003 Procedure A

The specimens were tested dull side to dull side, shiny side to shiny side and dull side to shiny side. Periodically the specimens were checked for any sign of blocking by removing the 0.5 psi test load from the stack and pulling the sheets apart.

E. Dimensional changes when exposed at 194 F, 230 F, 266 F and 160 F at 90% Relative Humidity for six and twelve weeks. The widths were measured with a machinist's micrometer (to 0.001 inch) and the lengths were measured with a steel ruler (to 0.01 inch).

**Conditioning

Specimens tested at temperatures above and below room temperature were conditioned for a minimum of one hour at the test temperature. Aged specimens were conditioned for 40 hours at 73°F and 50% Relative Humidity prior to testing.

Results:

A Tensile Properties at Various Temperatures

Table One: Yield Strength

Test Temperature (F)	Averaged Yield Strength (PSI)	Δ Percent from Control
-40	3730	230
0	2170	92
73	1130	0
120	1100	-2.7

Table Two: Break Strength

Test Temperature (F)	Averaged Break Strength (PSI)	Δ Percent from Control
-40	4150	-21.1
0	5030	-4.3
73	5260	0
120	>4500	N/A

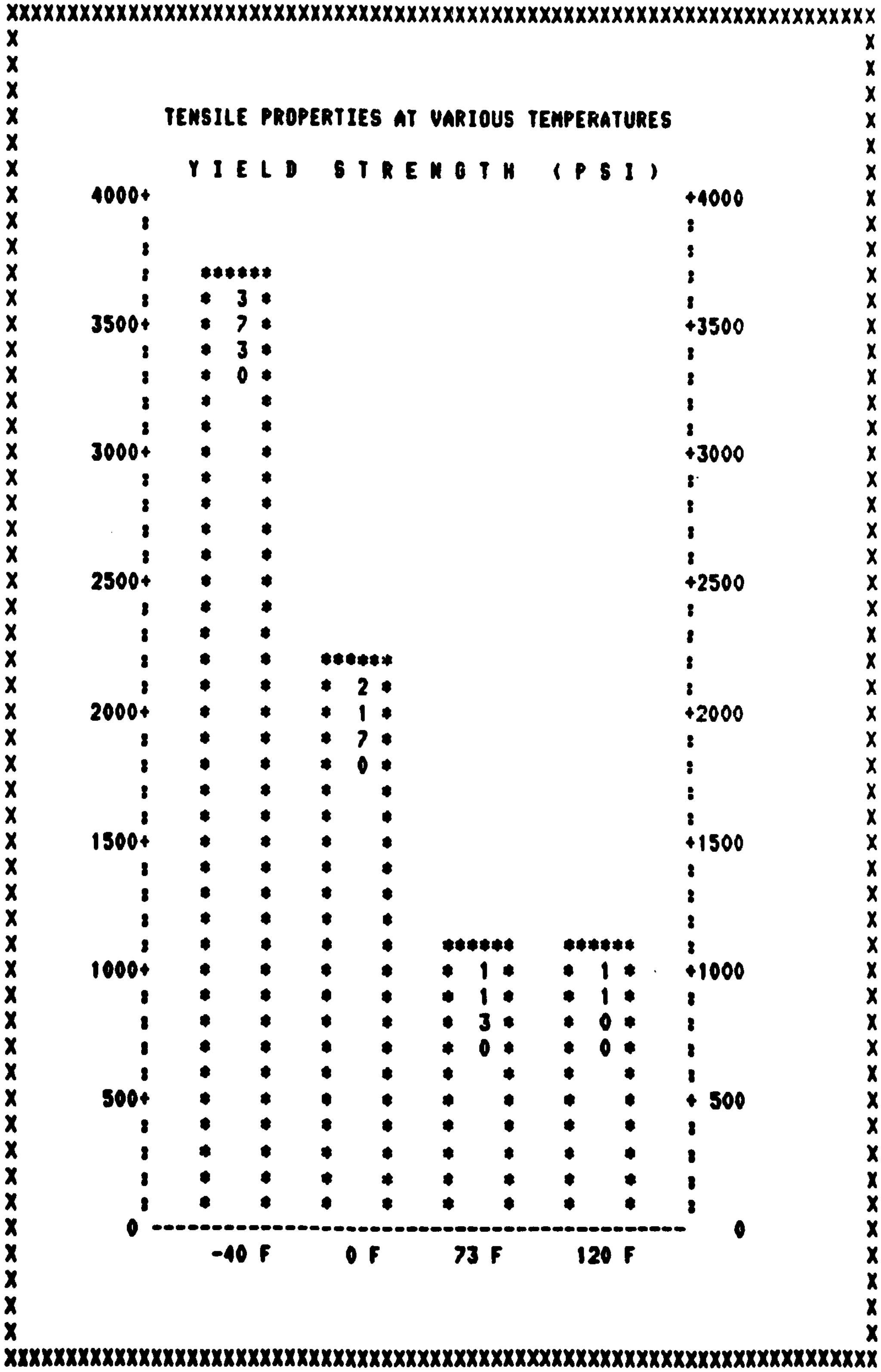
Table Three: Percent Elongation at Breakage

Test Temperature (F)	Averaged % Elongation at Breakage (%)	Δ Percent from Control
-40	540	-10
0	640	6.7
73	600	0
120	>700	N/A

Table Four: Modulus

Test Temperature (F)	Averaged Modulus (10^5 p.s.i.)	Δ Percent from Control
-40	5.0	3471
0	.18	28.5
73	.14	0
120	.08	-42.9

Graph One:


TENSILE PROPERTIES AT VARIOUS TEMPERATURES
YIELD STRENGTH (PSI)
4000
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3000
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2000
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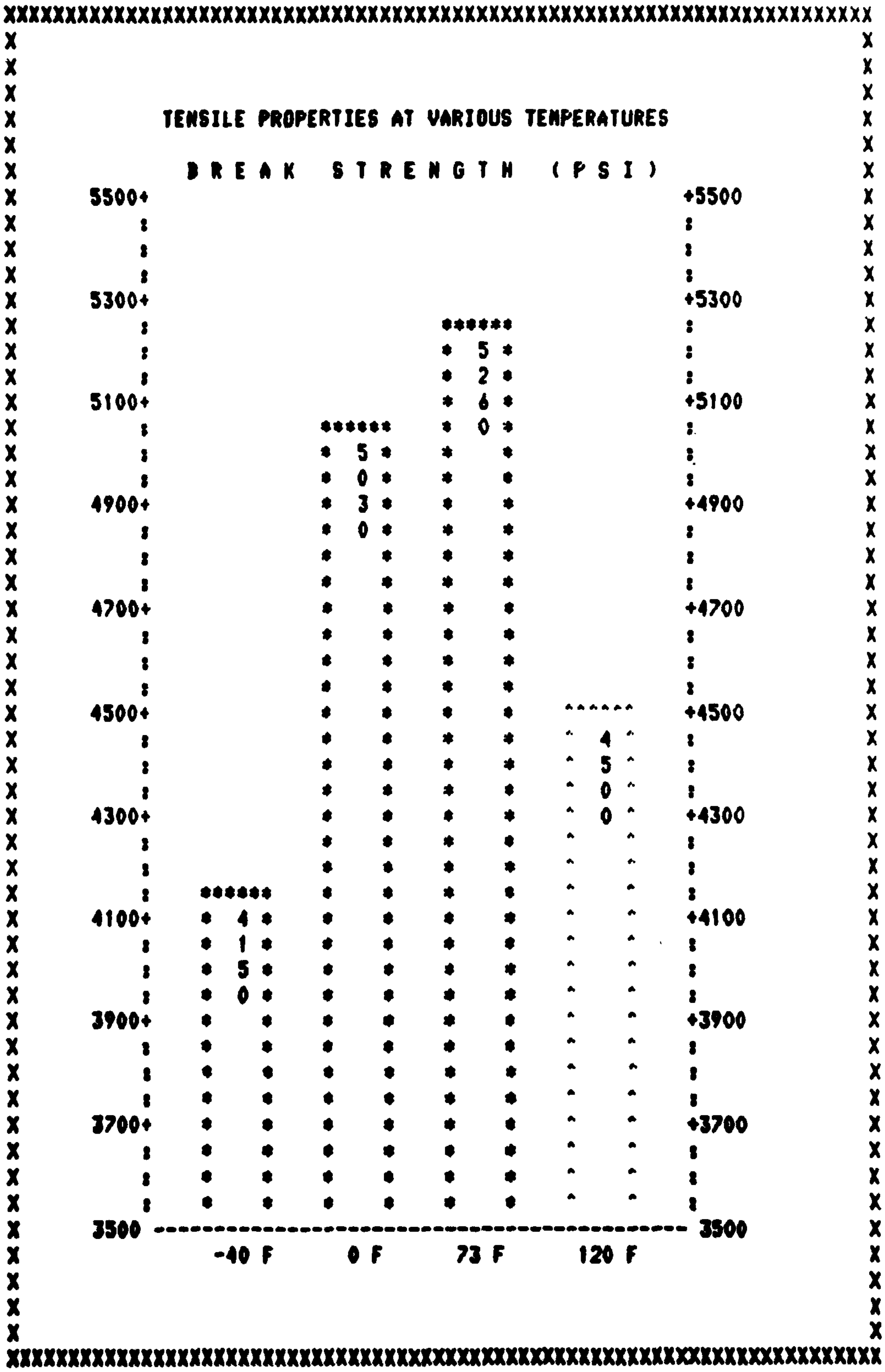
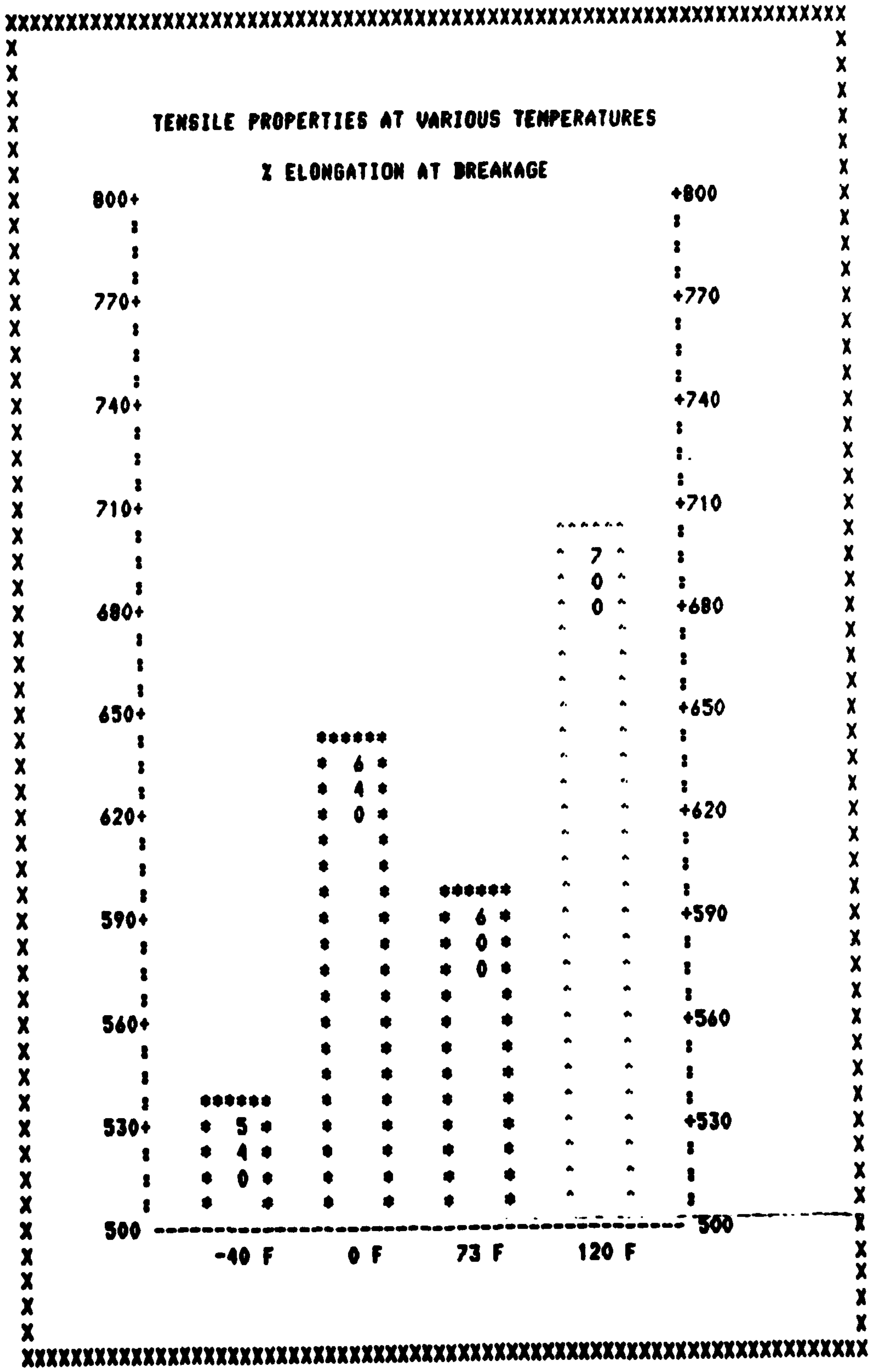
0
3730
2170
1130
1100
-40 F
0 F
73 F
120 F

Graph Two:


TENSILE PROPERTIES AT VARIOUS TEMPERATURES
BREAK STRENGTH (PSI)
5500
5300
5100
4900
4700
4500
4300
4100
3900
3700
3500
4150
5030
5260
4500
-40 F
0 F
73 F
120 F

Graph Three:


TENSILE PROPERTIES AT VARIOUS TEMPERATURES
% ELONGATION AT BREAKAGE
800
770
740
710
680
650
620
590
560
530
500
540
640
600
700
-40 F
0 F
73 F
120 F

Graph Four:

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                 TENSILE PROPERTIES AT VARIOUS TEMPERATURES

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   3.750+    *    *                                           +3.750
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   0.500+    *    *        1          1          0            +0.500
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   0.250+    *    *        0          0          0            +0.250
        :    *    *     ******     ******     ******          :
   0.000 ----------------------------------------------------- 0.000
              -40 F       0 F       73 F       120 F
```

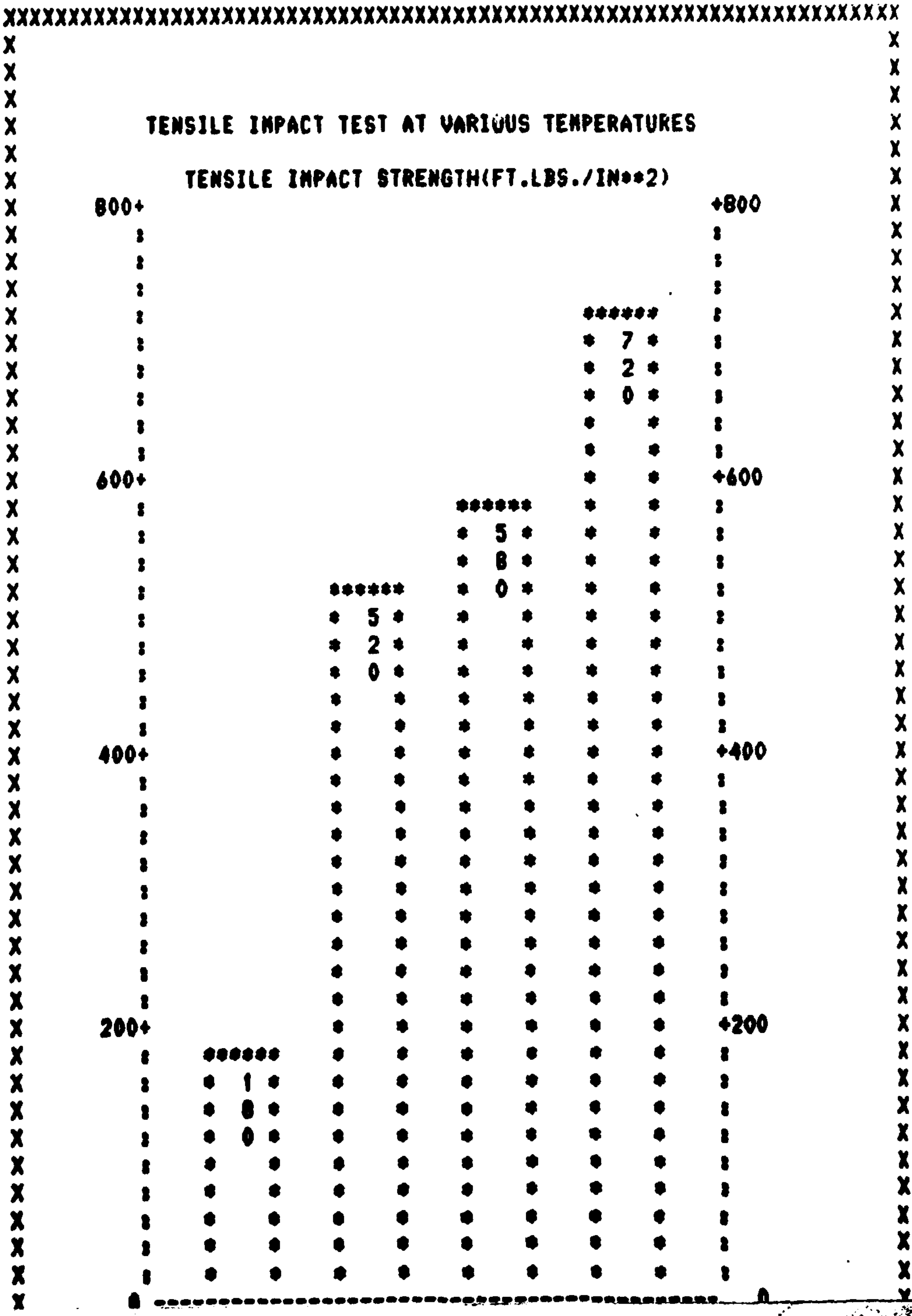
Results:

B Tensile Impact Tests at Various Temperatures

Table Five: Tensile Impact Strength

Test Temperature (F)	Averaged Tensile Impact Strength (ft.-lbs./in.^{2})	Δ Percent from Control
-40	180	-68.9
0	520	-10.3
73	580	0
120	720	24.1

Graph Five



Results:

C Tensile Properties at Various Thermal and Moisture Exposures

Table Six: Yield Strength

Exposure Conditions		Averaged Yield Strength (PSI)	△ Percent from Control
Control		1130	0
160°F, 90% R.H.,	6 wks	1630	44.2
	12 wks	1830	61.9
194°F	6 wks	1380	22.1
	12 wks	1390	23.0
230°F	6 wks	2200	94.7
	12 wks	Too brittle to test	
266°F	1 wk	Too brittle to test	
	3 wks	Too brittle to test	
	6 wks	Too brittle to test	
	12 wks	Too brittle to test	

Table Seven: Break Strength

Exposure Conditions		Averaged Break Strength (PSI)	△ Percent from Control
Control		5260	0
160°F, 90% R.H.,	6 wks	4930	-6.3
	12 wks	3910	-25.7
194°F	6 wks	2300	-56.3
	12 wks	1660	-68.4
230°F	6 wks	2700	-48.7
	12 wks	Too brittle to test	
266°F	1 wk	Too brittle to test	
	3 wks	Too brittle to test	
	6 wks	Too brittle to test	
	12 wks	Too brittle to test	

Results:

C Tensile Properties at Varicus Thermal and Moisture Exposures

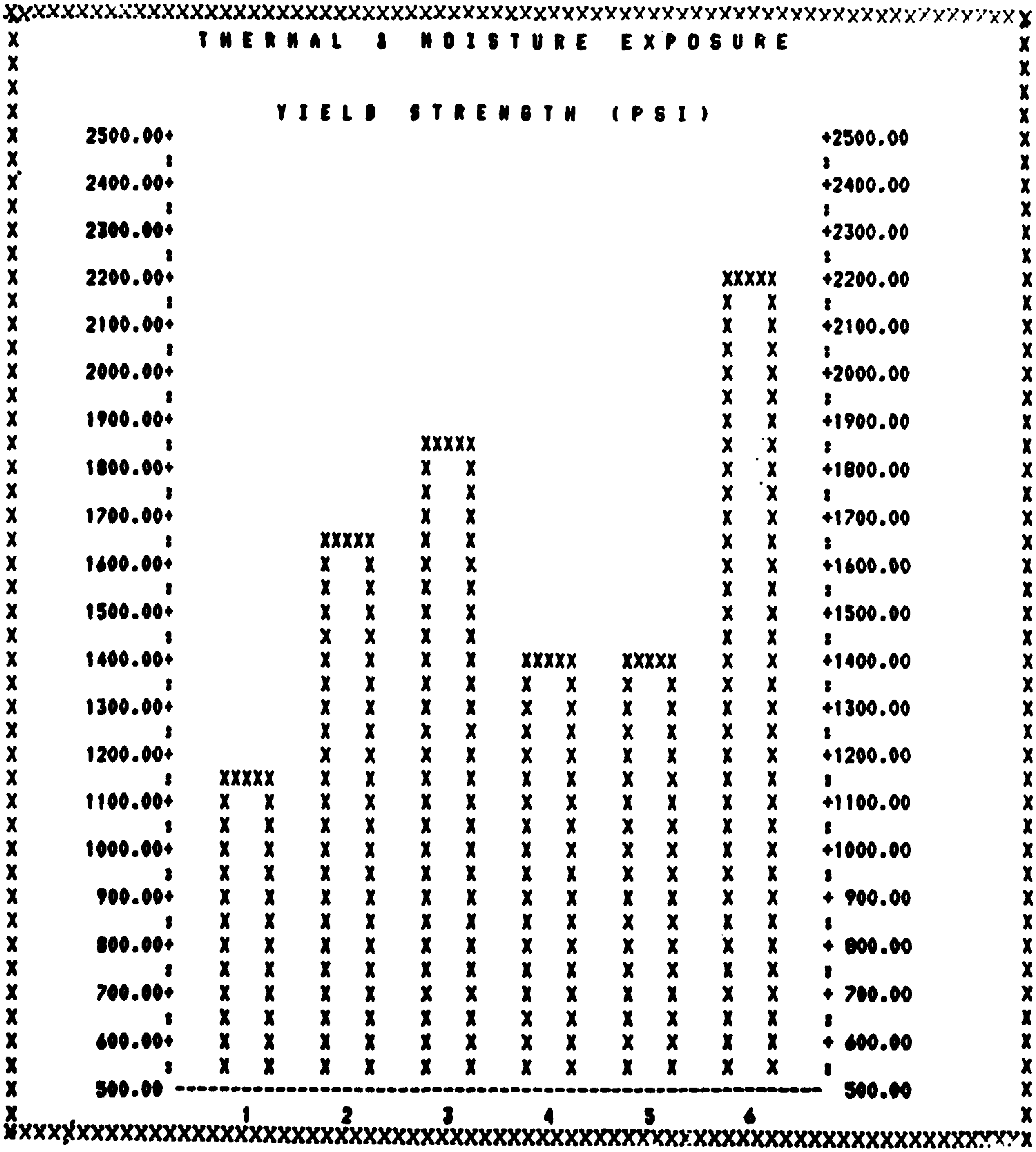
Table Eight: Percent Elongation at Breakage

Exposure Condition		Elongation at Breakage	Δ Percent from Control
Control		600	0
160°F, 90% R.H.,	6 wks	1060	76.7
	12 wks	850	41.7
194°F	6 wks	790	31.7
	12 wks	560	-6.7
230°F	6 wks	590	1.7
	12 wks	Too brittle to test	
266°F	1 wk	Too brittle to test	
	3 wks	Too brittle to test	
	6 wks	Too brittle to test	
	12 wks	Too brittle to test	

Table Nine: Modulus

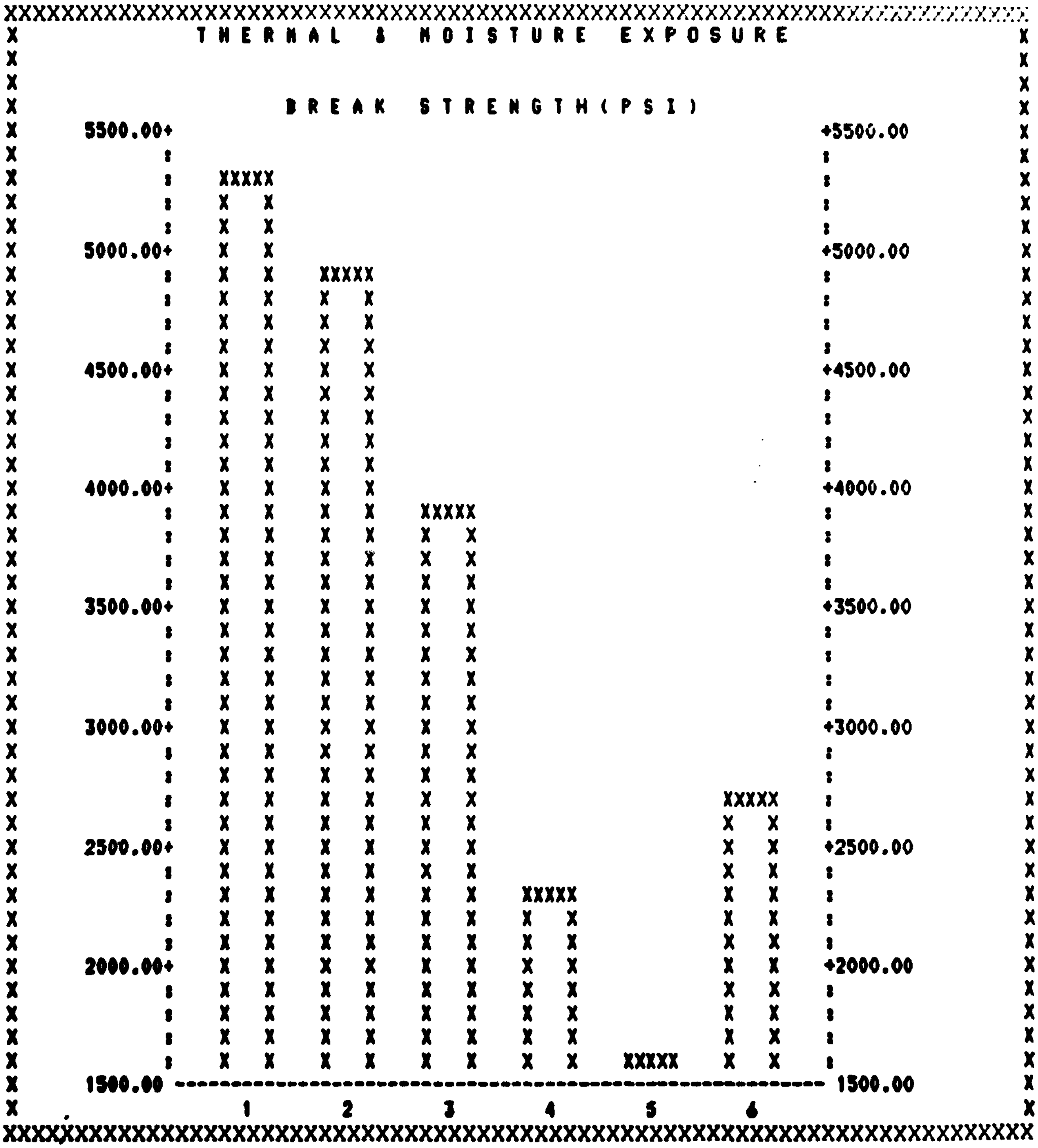
Exposure Condition		Averaged Modulus	Δ Percent from Control
Control		0.14	0
160°F, 90% R.H.,	6 wks	0.13	-7.1
	12 wks	0.14	0
194°F	6 wks	0.14	0
	12 wks	0.13	-7.1
230°F	6 wks	0.71	407.1
	12 wks	Too brittle to test	
266°F	1 wk	Too brittle to test	
	3 wks	Too brittle to test	
	6 wks	Too brittle to test	
	12 wks	Too brittle to test	

Graph Six



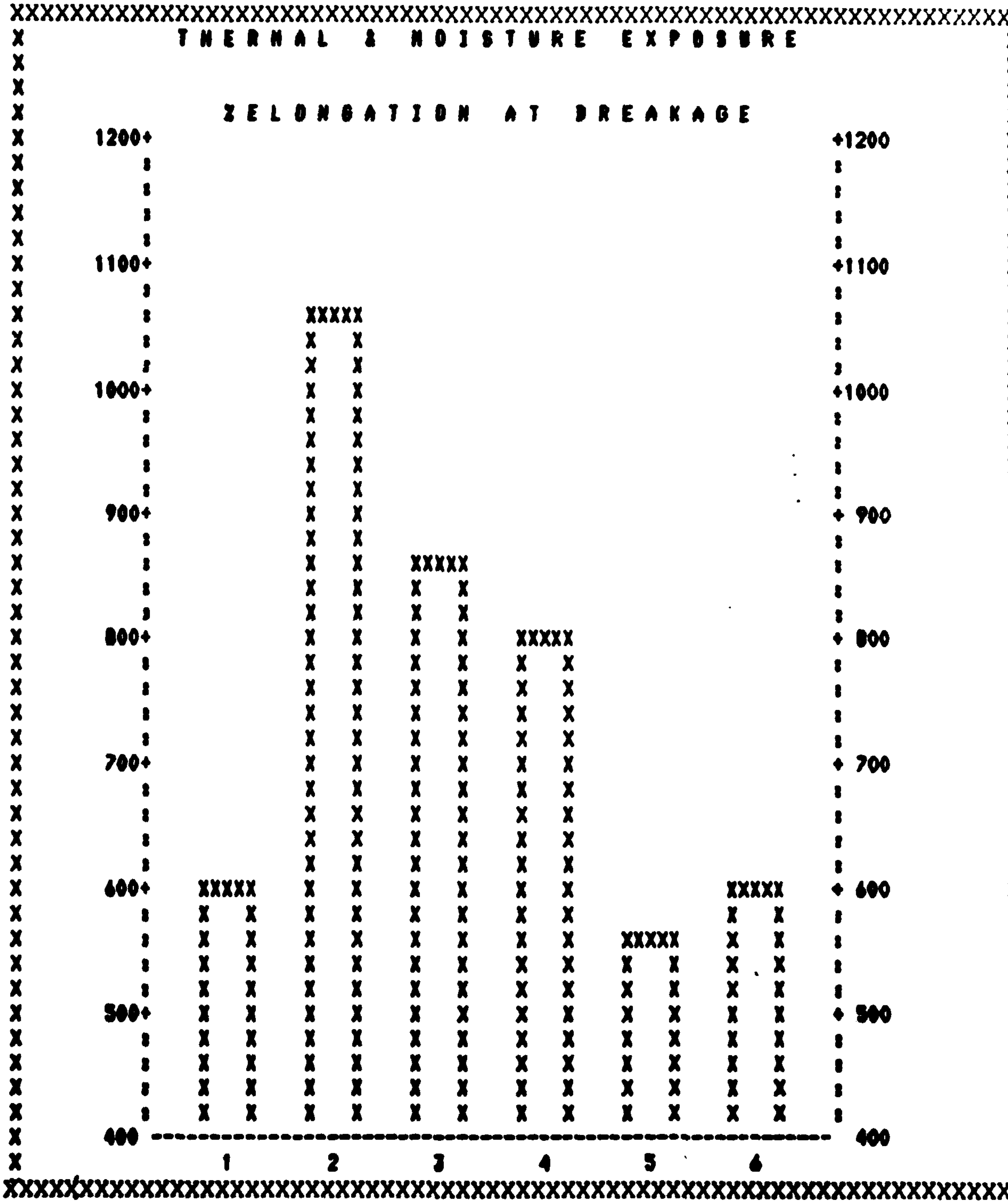
Bar	Exposure Condition		Value
1	Control		1130
2	160°F, 90% R.H.,	6 wks	1630
3		12 wks	1830
4	194°F	6 wks	1380
5		12 wks	1390
6	230°F	6 wks	2200

Graph Seven



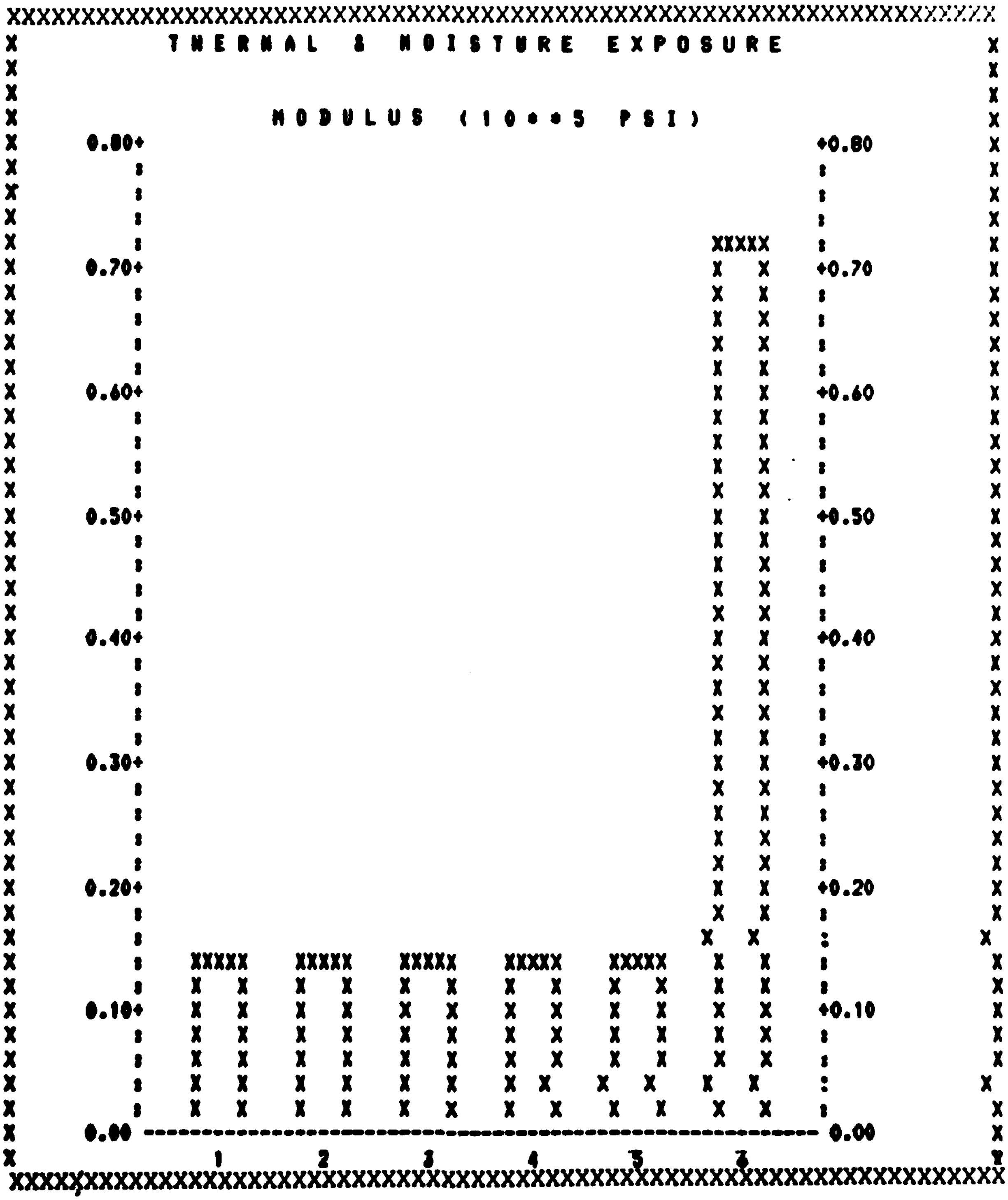
Bar	Exposure Condition		Value
1	Control		5250
2	160°F, 90% R.H.,	6 wks	4930
3		12 wks	3910
4	194°F	6 wks	2300
5		12 wks	1600
6	230°F	6 wks	2700

Graph Eight



Bar	Exposure Condition		Value
1	Control		600
2	160°F, 90% R.H.,	6 wks	1060
3		12 wks	850
4	194°F	6 wks	790
5		12 wks	560
6	230°F	6 wks	590

Graph Nine



Bar	Exposure Condition		Value
1	Control		0.14
2	160°F, 90% R.H.,	6 wks	0.13
3		12 wks	0.14
4	194°F	6 wks	0.14
5		12 wks	0.13
6	230°F	6 wks	0.71

Results:

D Tensile Impact Test at Various Thermal & Moisture Exposures

Table Ten: Tensile Impact Strength

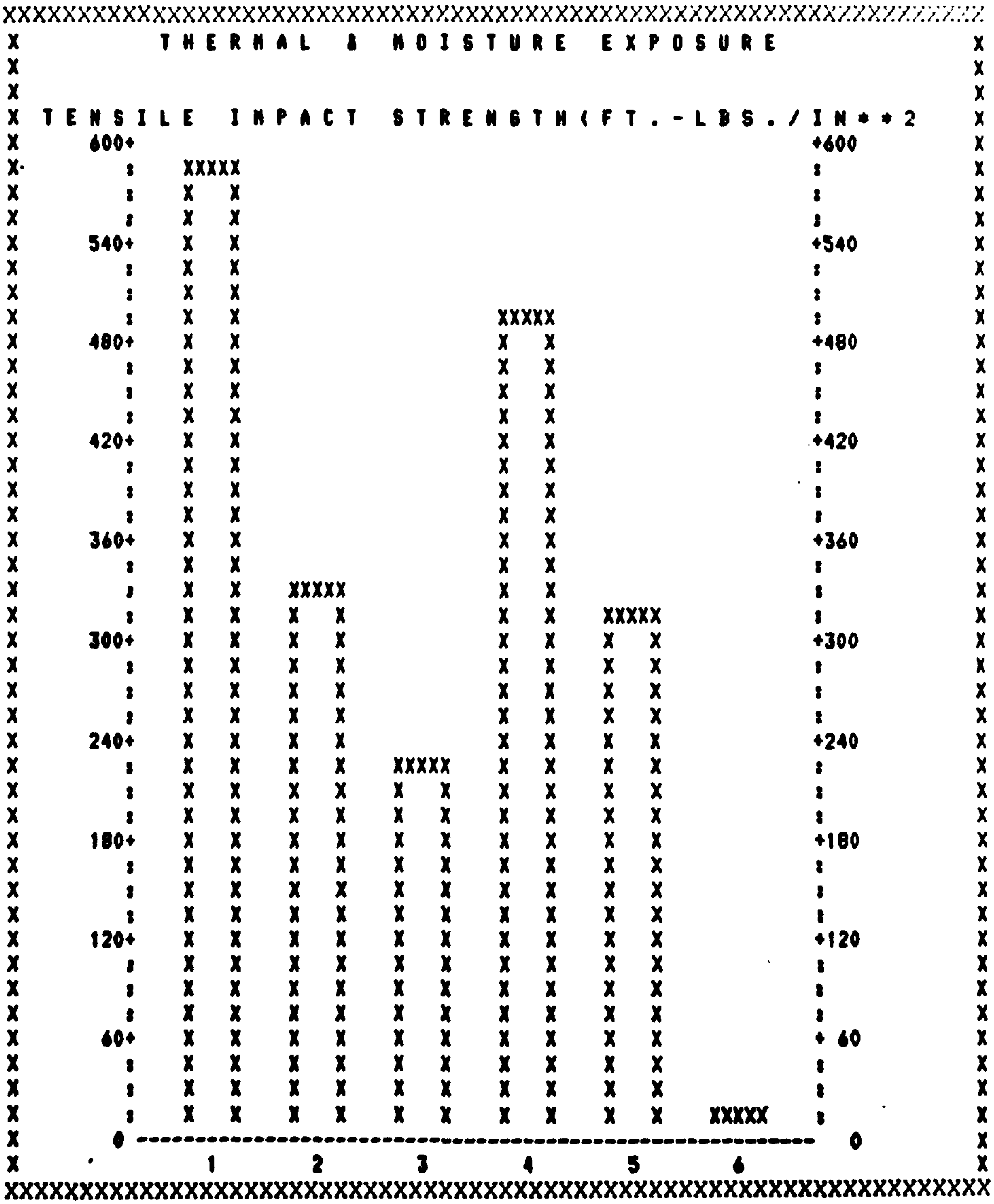
Exposure Condition		Averaged Tensile Impact Strength (ft.-lbs./in²)	Δ Percent from Control
Control		580	0
160°F, 90% R.H.,	6 wks	331	-42.9
	12 wks	220	-62.1
194°F	6 wks	500	-13.8
	12 wks	310	-46.6
230°F	6 wks	13	-97.8
	12 wks	Too brittle to test	
266°F	1 wk	Too brittle to test	
	3 wks	Too brittle to test	
	6 wks	Too brittle to test	
	12 wks	Too brittle to test	

E Blocking Characteristics at Various Temperatures

Table Eleven

Test Conditions	Test Results
-60°F	
after 1 day	no blocking
after 1 week	no blocking
after 1 month	no blocking
73°F	
after 1 day	no blocking
after 1 week	no blocking
after 1 month	no blocking
160°F	
after 1 day	no blocking
after 1 week	no blocking
after 1 month	no blocking

Graph Ten



Bar	Exposure Condition		Value
1	Control		580
2	160°F, 90% R.H.,	6 wks	331
3		12 wks	220
4	194°F	6 wks	500
5		12 wks	310
6	230°F	6 wks	13

Results:

F Dimensional Changes at Various Conditions

Table Eleven

Exposure Conditions		Δ Percent Length	Δ Percent Width
160°F, 90% R.H.,	6 wks	0.0	+0.1
194°F	6 wks	+0.3	-0.3
	12 wks	+0.2	-0.6
230°F	6 wks	+0.2	-0.9
	12 wks	+0.04	-0.9
266°F	1 wk	-0.2	+0.2
	3 wks	-0.2	-0.5
	6 wks	Too brittle to test	
	12 wks	Too brittle to test	

Discussion:

The regular use of dental floss to remove interproximal plaque accumulation is an important factor in controlling dental disease. The dental tape studied in this project was felt to have several positive benefits in a mobile military environment.

To assure its stability under hostile environmental conditions, the coated elastomer ribbon was subjected to various thermal conditions. It was found acceptable for use in a temperature range of 0 to 120°F. Due to high Modulus and low Tensile Impact Strength, the product will not function at -40°F. Break Strength and Percent Elongation at breakage could not be accurately determined at 120°F due to limitation of the machinery used in the study.

The coated, elastomeric dental ribbon was found suitable for storage at 194 F and 160°F with 90% relative humidity for 12 weeks. Heat aging characteristics may be improved by the incorporation of an antioxidant upon extrusion of the tape.

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